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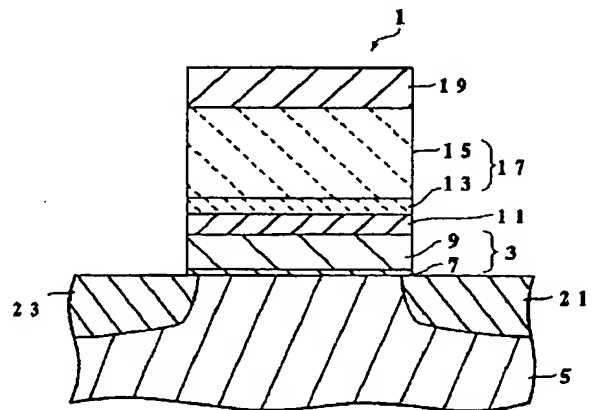
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(54)【発明の名称】 結晶性薄膜製造方法

(57)【要約】

【目的】 配向性に優れた結晶構造を有する薄膜を短時間で形成する方法を提供する。

【構成】 基板5上面に配向性に優れたチタン結晶体7を形成した後に成長速度の早い成膜条件でチタン結晶性薄膜9を成長させているから、チタン結晶体7の優れた配向性を受継いだチタン結晶性薄膜3を短時間で形成することができる。チタン結晶性薄膜3上面に白金薄膜11及びPZT薄膜をこの順で形成する。この際、PZT薄膜は、チタン結晶性薄膜3により基板から剥離することなく白金の優れた配向性を受継いだ優れた結晶構造を有する。



【特許請求の範囲】

【請求項1】半導体装置の製造における結晶性薄膜の製造方法であって、

配向性に優れた結晶構造を有する第一膜を成膜した後、成長速度の早い成膜条件で第二膜を形成することを特徴とする結晶性薄膜製造方法。

【請求項2】請求項1の結晶性薄膜製造方法において、第一膜と第二膜とが同一組成の膜であることを特徴とする結晶性薄膜製造方法。

【請求項3】請求項1の結晶性薄膜製造方法において、第一膜が白金膜であることを特徴とする結晶性薄膜製造方法。

【請求項4】半導体装置の製造における結晶性薄膜の製造方法であって、

配向性に優れた分離した状態の種結晶を成長させた後、成長速度の早い成膜条件で希望とする成膜を形成することを特徴とする結晶性薄膜製造方法。

【請求項5】請求項4の結晶性薄膜製造方法において、前記種結晶と希望の薄膜とが同一組成であることを特徴とする結晶性薄膜製造方法。

【請求項6】請求項4の結晶性薄膜製造方法において、前記種結晶が白金膜であることを特徴とする結晶性薄膜製造方法。

【請求項7】半導体装置の製造における結晶性薄膜の製造方法であって、

準備された基板上面に配向性に優れたチタン結晶を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成する工程と、前記チタン薄膜上面に白金薄膜を形成する工程と、前記白金薄膜上面に強誘電体薄膜を成長させる工程と、を備えたことを特徴とする結晶性薄膜製造方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、結晶性薄膜の製造方法に関し、特に成長速度の速い場合の配向性の向上に関する。

【0002】

【従来の技術】様々な結晶性薄膜が、半導体装置に利用されている。これらの薄膜においては、一般に配向性に優れた結晶構造が要求される。

【0003】例えば、結晶性薄膜の製造方法として、不揮発性半導体記憶装置（特に強誘電体不揮発性記憶装置）のメモリセルのゲート上に積層される多数の結晶性薄膜の製造方法について説明する。強誘電体不揮発性記憶装置は、強誘電体薄膜が有する残留分極性と分極反転性を記憶手段に利用したものである。なお、残留分極性とは、膜の性質の一つであり、その膜に対して電界を印加した場合に膜が分極し、この分極が電界を取り除いても残留するという性質をいう。また、分極反転性も膜の性質の一つであり、膜を分極させる為に印加した電界と

は反対方向の電界を印加することにより膜の分極状態が逆方向に変わるという性質をいう。

【0004】強誘電体不揮発性記憶装置のメモリセルの構造を図4に示す。ソース25及びドレイン27の設けられた基板29のゲート上にチタン薄膜31、白金薄膜33、強誘電性（PZT等）の薄膜35及び制御電極37がこの順に積層されている。

【0005】上記各薄膜の製造方法について、メモリセルの製造工程の流れに即して以下に説明する。図5にメモリセルの製造工程を断面構成図で示す。

【0006】図5のAに示すように、素子分離工程が施されたP形シリコン基板29上面に、電子ビーム蒸着法によりチタンのC軸配向性<001>の結晶性薄膜31を形成する。この場合、電子ビーム蒸着法は以下の条件で行うとよい。温度は300～500℃、電子銃パワーは180～300ワットとする。なお、この工程において前記の条件でチタン結晶を成長させた場合には希望の膜厚（50nm程度）のチタン薄膜31を形成するのに十数分を要する。

【0007】次に、図5Bに示すように、CVD法によりチタン薄膜31の上面に白金薄膜33を形成する。次に、ゾル-ゲル法により白金薄膜33の上面に強誘電体薄膜であるPZT薄膜35を膜厚50nm程度形成する。このゾル-ゲル法では、まず、ゾル溶液の調整を行う。次に、スピンコート法により調整済のゾル溶液を塗布し、乾燥する。次に、酸素雰囲気中700℃、20秒の条件で焼結させる。上記の様な塗布・乾燥・焼結工程を複数回繰り返すことにより希望膜厚を得るようにしている。

【0008】なお、チタン薄膜31は、基板29と白金薄膜33との剥離を防止する為に設けられている。また、白金結晶というのは優先配向性を有する。優先配向性というのは、下地の結晶性にかかわらず配向性を有した結晶が成長する性質をいう。従って、白金膜は下地の結晶性にかかわらず配向性に優れた結晶を有する。しかし、白金薄膜33は、上述のように配向性に優れたチタン薄膜31を基板29上面に形成した後白金薄膜を形成するようにしているから、さらに配向性に優れた白金薄膜33を形成することが出来る。従って、上述のようにこの配向性に優れた白金薄膜33を下地として利用することにより、結晶性に優れた強誘電体薄膜35を形成することが出来る。

【0009】なお、次に、図6に示すように強誘電体薄膜35の上面に制御電極37を形成した後、レジストをマスクにしてエッチングすることにより結晶性チタン薄膜31、白金薄膜33、PZT薄膜35、制御電極37を成形する。次に、制御電極37をマスクとして、ヒ素またはリンをイオン注入および熱拡散させて、n⁺形ソース層25及びn⁺形ドレイン層27を形成する。

【0010】以上のようにして形成されたメモリセル1

では、基板29と制御電極37間に電界VPを印加することにより、強誘電体薄膜は電界VP方向に分極し、電界VPを取り除いても分極は残留する。一方、電界VPとは反対方向の電界VQを基板29・制御電極37間に印加することにより、強誘電体薄膜の分極は、電界VQ方向に反転し、電界VQを取り除いても分極は残留する。

【0011】従って、メモリセル1は、強誘電体薄膜の上記のような残留分極及び分極反転の性質を利用することにより、情報を記憶することが出来る。

【0012】

【発明が解決しようとする課題】しかしながら、従来の結晶性薄膜製造方法には次のような問題点があった。

【0013】上記の様に、配向性に優れたチタン薄膜31及び白金薄膜33及びPZT薄膜35等を製造するには、特定の成膜条件で結晶を成長させる必要があった。一般に、配向性に優れた結晶を成長させることの出来る特定の成膜条件では、成長速度が遅かった。

【0014】従って、配向性に優れた薄膜を得る為に、結晶の成長速度の遅いことから、かなりの時間を要していた。特に、膜厚が厚い場合には問題となっていた。

【0015】よって、本発明は、上記の問題を解決し、形成時間を短縮したにもかかわらず配向性に優れた結晶構造を有する薄膜を形成する方法を提供することである。

【0016】

【課題を解決するための手段】請求項1に係る結晶性薄膜の製造方法は、配向性に優れた結晶構造を有する第一膜を成膜した後、成長速度の早い成膜条件で第二膜を形成することを特徴としている。

【0017】請求項2に係る結晶性薄膜製造方法は、第一膜と第二膜とが同一組成の膜であることを特徴としている。

【0018】請求項3に係る結晶性薄膜製造方法は、第一膜が白金膜であることを特徴としている。

【0019】請求項4に係る結晶性薄膜の製造方法は、配向性に優れた分離した状態の種結晶を成長させた後、成長速度の早い成膜条件で希望とする成膜を形成することを特徴としている。

【0020】請求項5に係る結晶性薄膜製造方法は、前記種結晶と希望の薄膜とが同一組成であることを特徴としている。

【0021】請求項6に係る結晶性薄膜製造方法は、前記種結晶が白金膜であることを特徴としている。

【0022】請求項7に係る結晶性薄膜製造方法は、準備された基板上面に配向性に優れたチタン結晶を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成する工程と、前記チタン薄膜上面に白金薄膜を形成する工程と、前記白金薄

膜上面に強誘電体薄膜を成長させる工程とを備えたことを特徴としている。

【0023】

【作用】請求項1及び請求項2及び請求項3に係る結晶性薄膜製造方法では、配向性に優れた第一膜を形成した後に、第一膜上面に成長速度の早い成膜条件で結晶を成長させるようにしている。

【0024】従って、第一膜は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【0025】請求項4及び請求項5及び請求項6に係る結晶性薄膜の製造方法では、配向性に優れた分離した状態の種結晶を成長させた後に、前記種結晶の上に成長速度の早い成膜条件で結晶を成長させるようにしている。

【0026】従って、前記種結晶は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【0027】請求項7に係る結晶性薄膜の製造方法では、準備された基板上面に配向性に優れたチタン結晶を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成するようにしている。

【0028】従って、前記チタン結晶は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れたチタン成膜を成長させることが出来る。

【0029】また、前記チタン薄膜上面に白金薄膜を形成するようにしている。

【0030】従って、白金は元来優先配向性を有しているが、前記チタン薄膜が配向性に優れた下地として働くことによりさらに配向性に優れた白金薄膜を成長させることが出来る。また、前記チタン薄膜は、前記基板および前記白金薄膜のどちらにも密着性を有する。

【0031】前記白金薄膜上面に強誘電体薄膜を成長させるようにしている。

【0032】従って、さらに配向性に優れた前記白金薄膜が下地として働くことにより、配向性に優れた強誘電体薄膜を成長させることが出来る。

【0033】

【実施例】本発明に係る結晶性薄膜製造方法を用いた一実施例として強誘電体不揮発性記憶装置のメモリセル1のゲート上に積層される結晶性薄膜の製造方法について、メモリセル1の製造工程に即して以下に説明する。図1A、B、C及び図2A、B及び図3に製造工程を断面構成図で示す。

【0034】図1Aに示すようにメモリセル1を形成する為に、まずシリコンウエーハ5が準備される。

【0035】次に、図1B及びCに示すように、シリコンウエーハ5の上面に電子ビーム蒸着法によりC軸配向性<001>のチタン結晶性薄膜3を形成する。この場合、電子ビーム蒸着法は以下の様に異なった条件で2工

程に分けて行う。初めの第一工程では、温度を300°Cから400°C、例えば350°Cとし、電子銃パワーを180~300ワットに設定し、第一膜として膜厚が数nm程度になるまでチタン結晶7を成長させる。次の第二工程では、温度を500°Cから600°C、例えば550°Cとし、電子銃パワーを180~300ワットに設定し、第二膜としてチタン結晶性薄膜9を成長させ、希望膜厚(50nm程度)のチタン結晶性薄膜3を得る。

【0036】なお、第一工程の温度条件(350°C)によるチタン結晶の成長では、配向性に優れたC軸配向性<001>のチタン結晶を成長させることは出来るが、成長速度が遅い。また、第二工程の温度条件(550°C)でチタン結晶を成長させた場合、成長速度は早いが普通<011>配向のチタン結晶が成長する。しかしながら、この実施例においては第一工程に続いて第二工程を行うことにより、第二工程の温度条件でもC軸配向性<001>のチタン結晶を早い成長速度のままで成長させることが出来る。従って、シリコンウエーハ5の上面に数分で配向性に優れたC軸配向<001>のチタン結晶性薄膜3(膜厚50nm程度)を形成することが出来る。

【0037】なお、この実施例ではチタン結晶7は第一膜として膜厚数nm程度に成膜しているが、その代りに配向性に優れた分離した状態の種結晶を形成するだけでもよい。この場合も、<011>配向の結晶が成長する成膜条件にもかかわらず、その上面には配向性に優れたC軸配向性<001>のチタン結晶性薄膜を形成することが出来る。

【0038】また、この実施例においては、第一膜または種結晶の上に組成が同じである第二膜を成長させているが、第二膜として異なった組成の結晶を成長させることも出来る。

【0039】次に、図2Aに示すように、チタン結晶性薄膜3の上面にCVD法により<111>配向の白金薄膜11を形成する。なお、白金は元来下地にかかわらず優先配向することにより配向性に優れた結晶が成長する。しかしこの実施例においては、<111>配向を有する白金の格子間距離に近いC軸配向性<001>のチタン結晶性薄膜3を下地として設けた後に白金を成長させているから、成長した白金の結晶はさらに良好な配向性を示す。

【0040】また、この時チタン薄膜3をシリコンウエーハ5と白金薄膜11との間に設けたことにより、シリコンウエーハ5からの白金薄層11の剥離を防ぐことができる。

【0041】次に、図2Aに示すように、ゾル・ゲル法により強誘電体薄膜であるPZT薄膜13が白金薄膜11上面に形成される。ここで、このゾル・ゲル法によるPZT薄膜の形成方法は、以下の様に行われる。

【0042】まず、ゾル溶液の調整を行う。ゾル溶液は、PZTをPb:Zr:Ti=1:0.58:0.48のモル比に調

整される。

【0043】次に、スピンコート法により3000rpmの条件下で調整済のゾル溶液を塗布し、100°C、15分の条件で乾燥した後、RTA(Rapid Thermal Annealing)の装置を使用し、酸素雰囲気中750°C、20秒の条件で焼結させ、膜厚50nm程度のPZT薄膜13を形成する。

【0044】上述の様に、この実施例においては第一膜として白金薄膜11を設けた後に第二膜として結晶性薄膜であるPZT薄膜13を形成するようにしている。従って、白金薄膜11の良好な配向性を受継いだPZT薄膜13を形成することが出来る。

【0045】なお、白金薄膜の代りに配向性に優れた分離した状態の白金種結晶を形成するだけでもよい。この場合もこの白金種結晶の配向性を受継いだPZT薄膜を形成することが出来る。また、この白金結晶のように素子の機能に直接関係しない場合は、不必要な成分は出きるだけ少なくするという意味で成膜せずに分離した状態の種結晶を用いた方がよい。

【0046】さらに、マグネトロンスパッタリング法(温度条件610°C)によりPZT薄膜13上面にPZT薄膜15を成長させ合せて膜厚200nmのPZT薄膜17を形成する。

【0047】上述の様に、この実施例においてはPZT薄膜17を二回の工程に分けて(別の方法で)形成している。初めのゾル・ゲル法により白金薄膜の配向性を受継いだ配向性に優れたPZT薄膜を第一膜として形成した後、スパッタリング法を用いて第二膜としてPZT結晶を成長させ、PZT薄膜17の膜厚を200nmとしている。

【0048】なお、次に、PZT薄膜17上面にスパッタリング法により白金薄膜19を堆積させた後、レジストをマスクにしてエッチングすることにより結晶性チタン薄膜8、白金薄膜11、PZT薄膜17、白金薄膜19を成形する。次に、白金薄膜19をマスクにして、ヒ素またはリンをイオン注入および熱拡散させて、n⁺形ドレイン層21およびn⁺形ソース層23を形成する。以上のようにしてメモリセルが形成される。

【0049】

【発明の効果】請求項1及び請求項2及び請求項3に係る結晶性薄膜製造方法では、配向性に優れた第一膜を形成した後に、第一膜上面に成長速度の早い成膜条件で結晶を成長させるようにしている。よって第一膜は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【0050】従って、配向性に優れた結晶構造を有する薄膜を短時間で形成することが出来る。

【0051】請求項4及び請求項5及び請求項6に係る結晶性薄膜の製造方法では、配向性に優れた分離した状態の種結晶を成長させた後に、前記種結晶の上に成長速

7

度の早い成膜条件で結晶を成長させるようにしている。よって前記種結晶は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることができる。

【0052】従って、配向性に優れた結晶構造を有する薄膜を短時間で形成することができる。

【0053】請求項7に係る結晶性薄膜の製造方法では、基板上面に配向性に優れたチタン結晶を形成した後、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成するようにしている。よって前記チタン結晶は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れたチタン成膜を成長させることができる。

【0054】従って、配向性に優れた希望膜厚のチタン成膜を短時間で形成することができる。

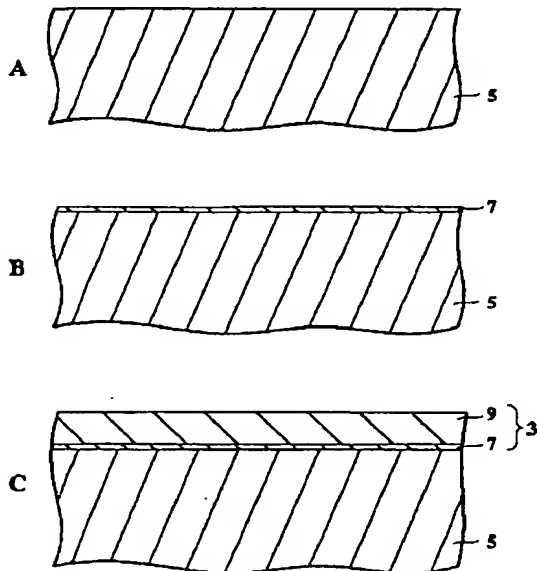
【0055】また、前記チタン薄膜上面に白金薄膜を形成するようにしている。

【0056】従って、白金は元来優先配向性を有しているが、前記チタン薄膜が配向性に優れた下地として働くことによりさらに配向性に優れた白金薄膜を形成することが出来る。また、前記チタン薄膜は前記基板および前記白金薄膜のどちらにも密着性があるから、前記基板と前記白金薄膜の剥離を防ぐことができる。

【0057】また、前記白金薄膜上面に強誘電体薄膜を成長させるようにしている。

*

【図1】



3 : チタン結晶性薄膜
5 : シリコンウエーハ
7 : チタン結晶
9 : チタン結晶性薄膜

8

*【0058】従って、配向性に優れた前記白金薄膜が下地として働くことにより、配向性に優れた強誘電体薄膜を形成することが出来る。

【図面の簡単な説明】

【図1】本発明の一実施例による結晶性薄膜の製造方法を示す為の製造工程図である。

【図2】本発明の一実施例による結晶性薄膜の製造方法を示す為の製造工程図である。

10 【図3】本発明の一実施例による結晶性薄膜を示す為の製造工程図である。

【図4】従来の結晶性薄膜を示す為の製造工程図である。

【図5】従来の結晶性薄膜を示す為の製造工程図である。

【図6】従来の結晶性薄膜を示す為の製造工程図である。

【符号の説明】

7・・・チタン結晶

9・・・チタン結晶性薄膜

3・・・チタン結晶性薄膜

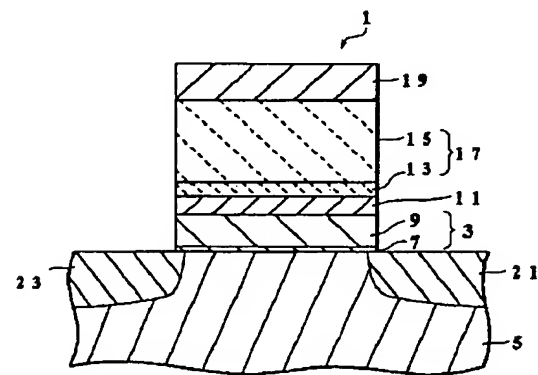
11・・・白金薄膜

13・・・PZT薄膜

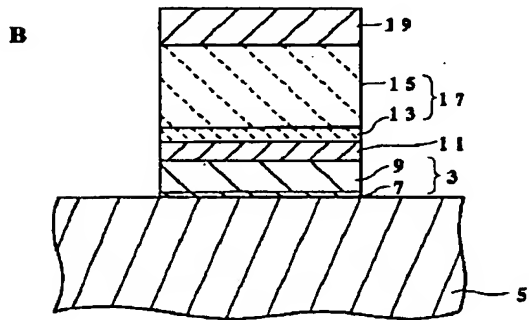
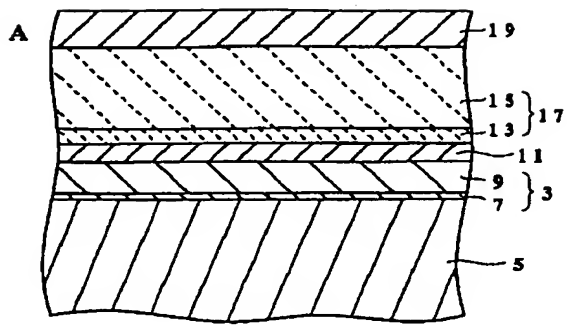
15・・・PZT薄膜

17・・・PZT薄膜

【図3】

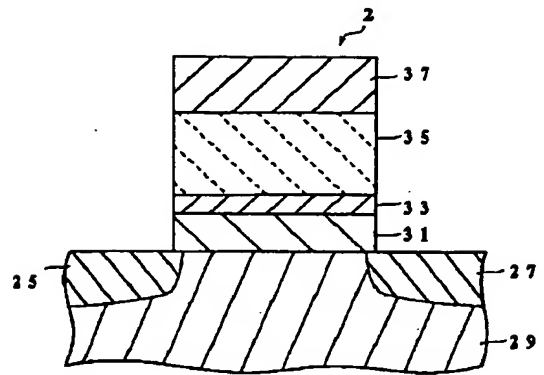


【図2】

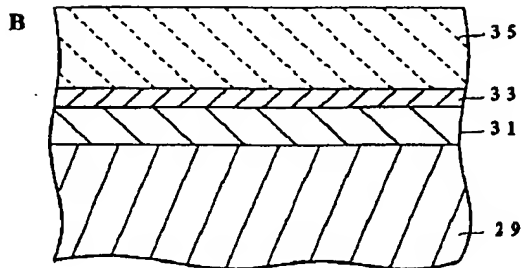
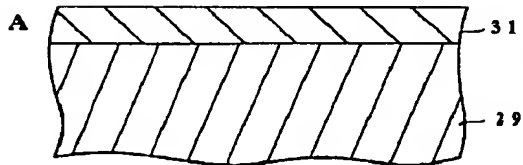


11:白金薄膜 15:PZT薄膜
13:PZT薄膜 17:PZT薄膜

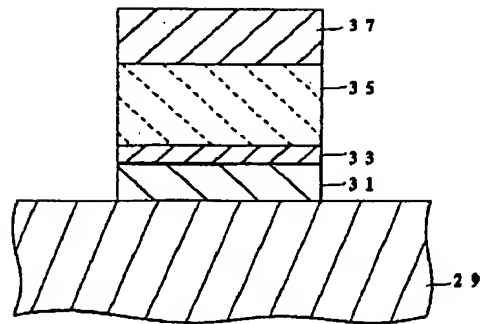
【図4】



【図5】



【図6】



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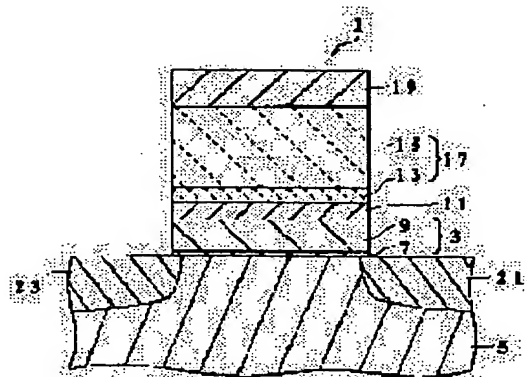
(72)Inventor : SAMEJIMA KATSUMI

(54) MANUFACTURE OF CRYSTALLINE THIN FILM

(57)Abstract:

PURPOSE: To provide a method of forming a thin film having a crystal structure, which is superior in orientation property, in a short time.

CONSTITUTION: A titanium crystal substance 7 having a superior orientation property is formed on the upper surface of a substrate 5 and thereafter, after a titanium crystalline thin film 9 is grown on the film formation condition of a quick growth rate, a titanium crystalline thin film 3 which maintains the superior orientation property of the crystal substance 7 can be formed in a short time. A platinum thin film 11 and a PZT thin film 17 are formed on the upper surface of the thin film 3 in the order of these thin films 11 and 17. At this time, the thin film 17 has a superior crystal structure inheriting the superior orientation property of platinum without being peeled from the substrate by the thin film 3.



LEGAL STATUS

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[Date of extinction of right] -

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3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The crystalline thin-film-fabrication method which is the manufacture method of the crystalline thin film in manufacture of a semiconductor device, and is characterized by forming the second film on the early membrane formation conditions of a growth rate after forming the first film which has the crystal structure excellent in the stacking tendency.

[Claim 2] The crystalline thin-film-fabrication method characterized by the first film and the second film being films of the same composition in the crystalline thin-film-fabrication method of a claim 1.

[Claim 3] The crystalline thin-film-fabrication method characterized by the first film being a platinum film in the crystalline thin-film-fabrication method of a claim 1.

[Claim 4] The crystalline thin-film-fabrication method which is the manufacture method of the crystalline thin film in manufacture of a semiconductor device, and is characterized by forming the membrane formation considered as hope on the early membrane formation conditions of a growth rate after growing up the seed crystal excellent in the stacking tendency in the state where it dissociated.

[Claim 5] The crystalline thin-film-fabrication method characterized by the aforementioned seed crystal and the thin film of hope being the same composition in the crystalline thin-film-fabrication method of a claim 4.

[Claim 6] The crystalline thin-film-fabrication method characterized by the aforementioned seed crystal being a platinum film in the crystalline thin-film-fabrication method of a claim 4.

[Claim 7] The manufacture method of the crystalline thin film in manufacture of a semiconductor device characterized by providing the following. The process which a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and forms titanium membrane formation of the thickness of choice after forming the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface. The process which forms a platinum thin film in the aforementioned titanium thin film upper surface, and the process which grows up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to improvement in the stacking tendency in the case of being quick of especially a growth rate about the manufacture method of a crystalline thin film.

[0002]

[Description of the Prior Art] Various crystalline thin films are used for the semiconductor device. In these thin films, the crystal structure which was generally excellent in the stacking tendency is required.

[0003] For example, the manufacture method of the crystalline thin film of a large number by which a laminating is carried out on the gate of the memory cell of a nonvolatile semiconductor memory (especially ferroelectric nonvolatile storage) is explained as the manufacture method of a crystalline thin film. A ferroelectric nonvolatile storage uses for a storage means the remanence nature and polarization parity which a ferroelectric thin film has. In addition, remanence nature is one of the membranous properties, and means the property to remain even if a film polarizes and this polarization removes electric field, when electric field are impressed to the film. Moreover, polarization parity is also one of the membranous properties, and the electric field impressed in order to carry out polarization of the film mean the property in which a membranous polarization state changes to an opposite direction, by impressing the electric field of opposite direction.

[0004] The structure of the memory cell of a ferroelectric nonvolatile storage is shown in drawing 4. The laminating of the titanium thin film 31, the platinum thin film 33, the thin film 35 of ferroelectricities (PZT etc.), and the control electrode 37 is carried out to this order on the gate of a substrate 29 in which the source 25 and the drain 27 were formed.

[0005] It is based on the flow of the manufacturing process of a memory cell, and the manufacture method of each above-mentioned thin film is explained below. A cross-section block diagram shows the manufacturing process of a memory cell to drawing 5.

[0006] As shown in A of drawing 5, the crystalline thin film 31 of C shaft stacking tendency <001> of titanium is formed in the P type silicon-substrate 29 upper surface where the isolation process was given by the electron-beam-evaporation method. In this case, as for an electron-beam-evaporation method, it is good to carry out on condition that the following. 300-500 degrees C and electron gun power make temperature 180-300W. In addition, when growing up a titanium crystal on condition that the above in this process, about ten minutes is taken to form the titanium thin film 31 of the thickness (about 50nm) of hope.

[0007] Next, as shown in drawing 5 B, the platinum thin film 33 is formed in the upper surface of the titanium thin film 31 by CVD. Next, the PZT thin film 35 which is a ferroelectric thin film is formed in the upper surface of the platinum thin film 33 about 50nm of thickness with a sol-gel method. In this sol-gel method, a sol solution is adjusted first. Next, an adjusted sol solution is applied by the spin coat method, and it dries. Next, it is made to sinter on 700 degrees C and the conditions for 20 seconds among oxygen atmosphere. It is made to obtain the thickness of choice by repeating the above application and dryness / sintering processes two or more times.

[0008] In addition, the titanium thin film 31 is formed in order to prevent ablation with a substrate 29 and the platinum thin film 33. Moreover, a platinum crystal has a priority stacking tendency. A priority stacking tendency says the property in which a crystal with the stacking tendency grows, irrespective of the crystallinity of a ground. Therefore, a platinum film has the crystal excellent in the stacking tendency irrespective of the crystallinity of a ground. However, since it is made to form a platinum thin film after the platinum thin film 33 forms in the substrate 29 upper surface the titanium thin film 31 which was excellent in the stacking tendency as mentioned above, it can form the platinum thin film 33 which was further excellent in the stacking tendency. Therefore, the ferroelectric thin film 35 excellent in crystallinity was able to be formed by using as a ground the platinum thin film 33 which was excellent in this stacking tendency as mentioned above.

[0009] In addition, next, as shown in drawing 6, after forming a control electrode 37 in the upper surface of the ferroelectric thin film 35, the crystalline titanium thin film 31, the platinum thin film 33, the PZT thin film 35, and a control electrode 37 are fabricated by using a resist as a mask and *****ing. next, the control electrode 37 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type source layer 25 and n+ type drain layer 27 are formed

[0010] In the memory cell 1 formed as mentioned above, by impressing electric field VP between a substrate 29 and a control electrode 37, a ferroelectric thin film is polarized in the electric-field VP direction, and even if it removes electric field VP, polarization remains. On the other hand, in electric field VP, by impressing the electric field VQ of opposite direction between substrate 29 and a control electrode 37, polarization of a ferroelectric thin film is reversed in the electric-field VQ direction, and even if it removes electric field VQ, polarization remains.

[0011] Therefore, a memory cell 1 can memorize information by using the above remanences of a ferroelectric thin film,

and the property of polarization reversal.

[0012]

[Problem(s) to be Solved by the Invention] However, there were the following troubles in the conventional crystalline thin-film-fabrication method.

[0013] As mentioned above, in order to manufacture the titanium thin film 31, the platinum thin film 33, and PZT thin film 35 grade excellent in the stacking tendency, the crystal needed to be grown up on specific membrane formation conditions. On the specific membrane formation conditions that the crystal excellent in the stacking tendency can generally be grown up, the growth rate was slow.

[0014] Therefore, in order to obtain the thin film excellent in the stacking tendency, most time was required from crystal-growth speed being slow. Especially, it had become a problem when thickness was thick.

[0015] Therefore, although this invention solved the above-mentioned problem and shortened formation time, it is offering the method of forming the thin film which has the crystal structure excellent in the stacking tendency.

[0016]

[Means for Solving the Problem] After the manufacture method of the crystalline thin film concerning a claim 1 forms the first film which has the crystal structure excellent in the stacking tendency, it is characterized by forming the second film on the early membrane formation conditions of a growth rate.

[0017] The crystalline thin-film-fabrication method concerning a claim 2 is characterized by the first film and the second film being films of the same composition.

[0018] The crystalline thin-film-fabrication method concerning a claim 3 is characterized by the first film being a platinum film.

[0019] After the manufacture method of the crystalline thin film concerning a claim 4 grows up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is characterized by forming the membrane formation considered as hope on the early membrane formation conditions of a growth rate.

[0020] The crystalline thin-film-fabrication method concerning a claim 5 is characterized by the aforementioned seed crystal and the thin film of hope being the same composition.

[0021] The crystalline thin-film-fabrication method concerning a claim 6 is characterized by the aforementioned seed crystal being a platinum film.

[0022] After the crystalline thin-film-fabrication method concerning a claim 7 forms the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, it grows up a titanium crystal on the early membrane-formation conditions of a growth rate, and is characterized by to have the process which forms titanium membrane formation of the thickness of choice, the process which forms a platinum thin film in the aforementioned titanium thin film upper surface, and the process which grows up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[0023]

[Function] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-fabrication method concerning a claim 1, a claim 2, and a claim 3.

[0024] Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.

[0025] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6.

[0026] Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0027] After forming the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7.

[0028] Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0029] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.

[0030] Therefore, although platinum has the priority stacking tendency originally, the platinum thin film which was further excellent in the stacking tendency can be grown up by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film.

[0031] It is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[0032] Therefore, when the aforementioned platinum thin film which was further excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be grown up.

[0033]

[Example] It is based on the manufacturing process of a memory cell 1, and the manufacture method of the crystalline thin film by which a laminating is carried out on the gate of the memory cell 1 of a ferroelectric nonvolatile storage as one

example using the crystalline thin-film-fabrication method concerning this invention is explained below. A cross-section block diagram shows a manufacturing process to drawing 1 A, B, and C, drawing 2 A and B, and drawing 3.

[0034] As shown in drawing 1 A, in order to form a memory cell 1, a silicon wafer 5 is prepared first.

[0035] Next, as shown in drawing 1 B and C, the titanium crystallinity thin film 3 of C shaft stacking tendency <001> is formed in the upper surface of a silicon wafer 5 by the electron-beam-evaporation method. In this case, on different conditions as follows, an electron-beam-evaporation method is divided into two processes, and is performed. At the first process, temperature is made into 300 degrees C to 400 degrees C, for example, 350 degrees C, electron gun power is set as 180-300W, and the titanium crystalline 7 is grown up until thickness is set to about several nm as the first film. At the second following process, temperature is made into 500 degrees C to 600 degrees C, for example, 550 degrees C, electron gun power is set as 180-300W, the titanium crystallinity thin film 9 is grown up as the second film, and the titanium crystallinity thin film 3 of the thickness (about 50nm) of choice is obtained.

[0036] In addition, a growth rate is slow although the titanium crystal of C shaft stacking tendency <001> excellent in the stacking tendency can be grown up in the titanium crystal growth by the temperature conditions (350 degrees C) of the first process. Moreover, when growing up a titanium crystal on the temperature conditions (550 degrees C) of the second process, although a growth rate is early, the titanium crystal of <011> orientation usually grows. However, the titanium crystal of C shaft stacking tendency <001> can be grown up also on the temperature conditions of the second process by performing the second process following the first process in this example with an early growth rate. Therefore, the titanium crystallinity thin film 3 (about 50nm of thickness) of C shaft orientation <001> which was excellent in several minutes at the stacking tendency can be formed in the upper surface of a silicon wafer 5.

[0037] In addition, it is also good to form the seed crystal excellent in the stacking tendency in the state where it dissociated, in this example, although the titanium crystalline 7 is forming membranes to about several nm thickness as the first film instead. The titanium crystallinity thin film of C shaft stacking tendency <001> excellent in the stacking tendency can be formed in the upper surface in spite of the membrane formation conditions the crystal of <011> orientation grows up to be also in this case.

[0038] Moreover, in this example, although composition is growing up the second same film on the first film or seed crystal, the crystal of different composition as the second film can also be grown up.

[0039] Next, as shown in drawing 2 A, the platinum thin film 11 of <111> orientation is formed in the upper surface of the titanium crystallinity thin film 3 by CVD. In addition, the crystal excellent in the stacking tendency grows by carrying out priority orientation of the platinum irrespective of a ground originally. However, in this example, since platinum is grown up after forming as a ground the titanium crystallinity thin film 3 of C shaft stacking tendency <001> near the distance between grids of the platinum which has <111> orientation, the grown-up crystal of platinum shows a still better stacking tendency.

[0040] Moreover, ablation of the platinum thin layer 11 from a silicon wafer 5 can be prevented by having formed the titanium thin film 3 between the silicon wafer 5 and the platinum thin film 11 at this time.

[0041] Next, as shown in drawing 2 A, the PZT thin film 13 which is a ferroelectric thin film is formed in the platinum thin film 11 upper surface by the sol-gel method. Here, the formation method of the PZT thin film by this sol-gel method is performed as follows.

[0042] First, a sol solution is adjusted. A sol solution is adjusted to the mole ratio of Pb:Zr:Ti=1:0.58:0.48 in PZT.

[0043] Next, after applying a sol solution adjusted in the bottom of the conditions of 3000rpm by the spin coat method and drying on 100 degrees C and the conditions for 15 minutes, use the equipment of RTA (Rapid Thermal Annealing), it is made to sinter on 750 degrees C and the conditions for 20 seconds among oxygen atmosphere, and the PZT thin film 13 of about 50nm of thickness is formed.

[0044] As mentioned above, after forming the platinum thin film 11 as the first film in this example, it is made to form the PZT thin film 13 which is a crystalline thin film as the second film. Therefore, the PZT thin film 13 which inherited the good stacking tendency of the platinum thin film 11 can be formed.

[0045] In addition, it is also good to form the platinum seed crystal in the state where it dissociated which was excellent in the stacking tendency instead of the platinum thin film. The PZT thin film which inherited the stacking tendency of this platinum seed crystal also in this case can be formed. Moreover, it is better to use the seed crystal in the state where it dissociated without forming membranes in the meaning of lessening as the unnecessary component has come out, when not directly related to the function of an element like this platinum crystal.

[0046] Furthermore, the PZT thin film 15 is grown up into the PZT thin film 13 upper surface by the magnetron sputtering method (610 degrees C of temperature conditions), and the PZT thin film 17 of 200nm of thickness is formed.

[0047] As mentioned above, in this example, the PZT thin film 17 is divided into the process of two times, and is formed (with option). After forming the PZT thin film excellent in the stacking tendency which inherited the stacking tendency of a platinum thin film with the first sol-gel method as the first film, the sputtering method is used, a PZT crystal is grown up as the second film, and thickness of the PZT thin film 17 is set to 200nm.

[0048] In addition, next, after making the platinum thin film 19 deposit on the PZT thin film 17 upper surface by the sputtering method, the crystalline titanium thin film 8, the platinum thin film 11, the PZT thin film 17, and the platinum thin film 19 are fabricated by using a resist as a mask and *****ing. next, the platinum thin film 19 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type drain layer 21 and n+ type source layer 23 are formed. A memory cell is formed as mentioned above.

[0049]

[Effect of the Invention] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-

fabrication method concerning a claim 1, a claim 2, and a claim 3. Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.

[0050] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.

[0051] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6. Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0052] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.

[0053] After forming the titanium crystalline excellent in the stacking tendency in the substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7. Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0054] Therefore, titanium membrane formation of the thickness of choice excellent in the stacking tendency can be formed in a short time.

[0055] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.

[0056] Therefore, although platinum has the priority stacking tendency originally, it can form the platinum thin film which was further excellent in the stacking tendency by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, since the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film, it can prevent exfoliation of the aforementioned substrate and the aforementioned platinum thin film.

[0057] Moreover, it is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[0058] Therefore, when the aforementioned platinum thin film excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be formed.

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TECHNICAL FIELD

[Industrial Application] this invention relates to improvement in the stacking tendency in the case of being quick of especially a growth rate about the manufacture method of a crystalline thin film.

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PRIOR ART

[Description of the Prior Art] Various crystalline thin films are used for the semiconductor device. In these thin films, the crystal structure which was generally excellent in the stacking tendency is required.

[0003] For example, the manufacture method of the crystalline thin film of a large number by which a laminating is carried out on the gate of the memory cell of a nonvolatile semiconductor memory (especially ferroelectric nonvolatile storage) is explained as the manufacture method of a crystalline thin film. A ferroelectric nonvolatile storage uses for a storage means the remanence nature and polarization parity which a ferroelectric thin film has. In addition, remanence nature is one of the membranous properties, and means the property to remain even if a film polarizes and this polarization removes electric field, when electric field are impressed to the film. Moreover, polarization parity is also one of the membranous properties, and the electric field impressed in order to carry out polarization of the film mean the property in which a membranous polarization state changes to an opposite direction, by impressing the electric field of opposite direction.

[0004] The structure of the memory cell of a ferroelectric nonvolatile storage is shown in drawing 4. The laminating of the titanium thin film 31, the platinum thin film 33, the thin film 35 of ferroelectricities (PZT etc.), and the control electrode 37 is carried out to this order on the gate of a substrate 29 in which the source 25 and the drain 27 were formed.

[0005] It is based on the flow of the manufacturing process of a memory cell, and the manufacture method of each above-mentioned thin film is explained below. A cross-section block diagram shows the manufacturing process of a memory cell to drawing 5.

[0006] As shown in A of drawing 5, the crystalline thin film 31 of C shaft stacking tendency <001> of titanium is formed in the P type silicon-substrate 29 upper surface where the isolation process was given by the electron-beam-evaporation method. In this case, as for an electron-beam-evaporation method, it is good to carry out on condition that the following. 300-500 degrees C and electron gun power make temperature 180-300W. In addition, when growing up a titanium crystal on condition that the above in this process, about ten minutes is taken to form the titanium thin film 31 of the thickness (about 50nm) of hope.

[0007] Next, as shown in drawing 5 B, the platinum thin film 33 is formed in the upper surface of the titanium thin film 31 by CVD. Next, the PZT thin film 35 which is a ferroelectric thin film is formed in the upper surface of the platinum thin film 33 about 50nm of thickness with a sol-gel method. In this sol-gel method, a sol solution is adjusted first. Next, an adjusted sol solution is applied by the spin coat method, and it dries. Next, it is made to sinter on 700 degrees C and the conditions for 20 seconds among oxygen atmosphere. It is made to obtain the thickness of choice by repeating the above application and dryness / sintering processes two or more times.

[0008] In addition, the titanium thin film 31 is formed in order to prevent ablation with a substrate 29 and the platinum thin film 33. Moreover, a platinum crystal has a priority stacking tendency. A priority stacking tendency says the property in which a crystal with the stacking tendency grows, irrespective of the crystallinity of a ground. Therefore, a platinum film has the crystal excellent in the stacking tendency irrespective of the crystallinity of a ground. However, since it is made to form a platinum thin film after the platinum thin film 33 forms in the substrate 29 upper surface the titanium thin film 31 which was excellent in the stacking tendency as mentioned above, it can form the platinum thin film 33 which was further excellent in the stacking tendency. Therefore, the ferroelectric thin film 35 excellent in crystallinity was able to be formed by using as a ground the platinum thin film 33 which was excellent in this stacking tendency as mentioned above.

[0009] In addition, next, as shown in drawing 6, after forming a control electrode 37 in the upper surface of the ferroelectric thin film 35, the crystalline titanium thin film 31, the platinum thin film 33, the PZT thin film 35, and a control electrode 37 are fabricated by using a resist as a mask and *****ing. next, the control electrode 37 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type source layer 25 and n+ type drain layer 27 are formed

[0010] In the memory cell 1 formed as mentioned above, by impressing electric field VP between a substrate 29 and a control electrode 37, a ferroelectric thin film is polarized in the electric-field VP direction, and even if it removes electric field VP, polarization remains. On the other hand, in electric field VP, by impressing the electric field VQ of opposite direction between substrate 29 and a control electrode 37, polarization of a ferroelectric thin film is reversed in the electric-field VQ direction, and even if it removes electric field VQ, polarization remains.

[0011] Therefore, a memory cell 1 can memorize information by using the above remanences of a ferroelectric thin film, and the property of polarization reversal.

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EFFECT OF THE INVENTION

[Effect of the Invention] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-fabrication method concerning a claim 1, a claim 2, and a claim 3. Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.

[0050] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.

[0051] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6. Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0052] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.

[0053] After forming the titanium crystalline excellent in the stacking tendency in the substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7. Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0054] Therefore, titanium membrane formation of the thickness of choice excellent in the stacking tendency can be formed in a short time.

[0055] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.

[0056] Therefore, although platinum has the priority stacking tendency originally, it can form the platinum thin film which was further excellent in the stacking tendency by working as a ground. The aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, since the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film, it can prevent exfoliation of the aforementioned substrate and the aforementioned platinum thin film.

[0057] Moreover, it is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[0058] Therefore, when the aforementioned platinum thin film excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be formed.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, there were the following troubles in the conventional crystalline thin-film-fabrication method.

[0013] As mentioned above, in order to manufacture the titanium thin film 31, the platinum thin film 33, and PZT thin film 35 grade excellent in the stacking tendency, the crystal needed to be grown up on specific membrane formation conditions. On the specific membrane formation conditions that the crystal excellent in the stacking tendency can generally be grown up, the growth rate was slow.

[0014] Therefore, in order to obtain the thin film excellent in the stacking tendency, most time was required from crystal-growth speed being slow. Especially, it had become a problem when thickness was thick.

[0015] Therefore, although this invention solved the above-mentioned problem and shortened formation time, it is offering the method of forming the thin film which has the crystal structure excellent in the stacking tendency.

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MEANS

[Means for Solving the Problem] After the manufacture method of the crystalline thin film concerning a claim 1 forms the first film which has the crystal structure excellent in the stacking tendency, it is characterized by forming the second film on the early membrane formation conditions of a growth rate.

[0017] The crystalline thin-film-fabrication method concerning a claim 2 is characterized by the first film and the second film being films of the same composition.

[0018] The crystalline thin-film-fabrication method concerning a claim 3 is characterized by the first film being a platinum film.

[0019] After the manufacture method of the crystalline thin film concerning a claim 4 grows up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is characterized by forming the membrane formation considered as hope on the early membrane formation conditions of a growth rate.

[0020] The crystalline thin-film-fabrication method concerning a claim 5 is characterized by the aforementioned seed crystal and the thin film of hope being the same composition.

[0021] The crystalline thin-film-fabrication method concerning a claim 6 is characterized by the aforementioned seed crystal being a platinum film.

[0022] After the crystalline thin-film-fabrication method concerning a claim 7 forms the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, it grows up a titanium crystal on the early membrane-formation conditions of a growth rate, and is characterized by to have the process which forms titanium membrane formation of the thickness of choice, the process which forms a platinum thin film in the aforementioned titanium thin film upper surface, and the process which grows up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

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OPERATION

[Function] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-fabrication method concerning a claim 1, a claim 2, and a claim 3.

[0024] Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.

[0025] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6.

[0026] Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0027] After forming the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7.

[0028] Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.

[0029] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.

[0030] Therefore, although platinum has the priority stacking tendency originally, the platinum thin film which was further excellent in the stacking tendency can be grown up by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film.

[0031] It is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[0032] Therefore, when the aforementioned platinum thin film which was further excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be grown up.

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EXAMPLE

[Example] It is based on the manufacturing process of a memory cell 1, and the manufacture method of the crystalline thin film by which a laminating is carried out on the gate of the memory cell 1 of a ferroelectric nonvolatile storage as one example using the crystalline thin-film-fabrication method concerning this invention is explained below. A cross-section block diagram shows a manufacturing process to drawing 1 A, B, and C, drawing 2 A and B, and drawing 3.

[0034] As shown in drawing 1 A, in order to form a memory cell 1, a silicon wafer 5 is prepared first.

[0035] Next, as shown in drawing 1 B and C, the titanium crystallinity thin film 3 of C shaft stacking tendency <001> is formed in the upper surface of a silicon wafer 5 by the electron-beam-evaporation method. In this case, on different conditions as follows, an electron-beam-evaporation method is divided into two processes, and is performed. At the first process, temperature is made into 300 degrees C to 400 degrees C, for example, 350 degrees C, electron gun power is set as 180-300W, and the titanium crystalline 7 is grown up until thickness is set to about several nm as the first film. At the second following process, temperature is made into 500 degrees C to 600 degrees C, for example, 550 degrees C, electron gun power is set as 180-300W, the titanium crystallinity thin film 9 is grown up as the second film, and the titanium crystallinity thin film 3 of the thickness (about 50nm) of choice is obtained.

[0036] In addition, a growth rate is slow although the titanium crystal of C shaft stacking tendency <001> excellent in the stacking tendency can be grown up in the titanium crystal growth by the temperature conditions (350 degrees C) of the first process. Moreover, when growing up a titanium crystal on the temperature conditions (550 degrees C) of the second process, although a growth rate is early, the titanium crystal of <011> orientation usually grows. However, the titanium crystal of C shaft stacking tendency <001> can be grown up also on the temperature conditions of the second process by performing the second process following the first process in this example with an early growth rate. Therefore, the titanium crystallinity thin film 3 (about 50nm of thickness) of C shaft orientation <001> which was excellent in several minutes at the stacking tendency can be formed in the upper surface of a silicon wafer 5.

[0037] In addition, it is also good to form the seed crystal excellent in the stacking tendency in the state where it dissociated, in this example, although the titanium crystalline 7 is forming membranes to about several nm thickness as the first film instead. The titanium crystallinity thin film of C shaft stacking tendency <001> excellent in the stacking tendency can be formed in the upper surface in spite of the membrane formation conditions the crystal of <011> orientation grows up to be also in this case.

[0038] Moreover, in this example, although composition is growing up the second same film on the first film or seed crystal, the crystal of different composition as the second film can also be grown up.

[0039] Next, as shown in drawing 2 A, the platinum thin film 11 of <111> orientation is formed in the upper surface of the titanium crystallinity thin film 3 by CVD. In addition, the crystal excellent in the stacking tendency grows by carrying out priority orientation of the platinum irrespective of a ground originally. However, in this example, since platinum is grown up after forming as a ground the titanium crystallinity thin film 3 of C shaft stacking tendency <001> near the distance between grids of the platinum which has <111> orientation, the grown-up crystal of platinum shows a still better stacking tendency.

[0040] Moreover, ablation of the platinum thin layer 11 from a silicon wafer 5 can be prevented by having formed the titanium thin film 3 between the silicon wafer 5 and the platinum thin film 11 at this time.

[0041] Next, as shown in drawing 2 A, the PZT thin film 13 which is a ferroelectric thin film is formed in the platinum thin film 11 upper surface by the sol-gel method. Here, the formation method of the PZT thin film by this sol-gel method is performed as follows.

[0042] First, a sol solution is adjusted. A sol solution is adjusted to the mole ratio of Pb:Zr:Ti=1:0.58:0.48 in PZT.

[0043] Next, after applying a sol solution adjusted in the bottom of the conditions of 3000rpm by the spin coat method and drying on 100 degrees C and the conditions for 15 minutes, use the equipment of RTA (Rapid Thermal Annealing), it is made to sinter on 750 degrees C and the conditions for 20 seconds among oxygen atmosphere, and the PZT thin film 13 of about 50nm of thickness is formed.

[0044] As mentioned above, after forming the platinum thin film 11 as the first film in this example, it is made to form the PZT thin film 13 which is a crystalline thin film as the second film. Therefore, the PZT thin film 13 which inherited the good stacking tendency of the platinum thin film 11 can be formed.

[0045] In addition, it is also good to form the platinum seed crystal in the state where it dissociated which was excellent in the stacking tendency instead of the platinum thin film. The PZT thin film which inherited the stacking tendency of this platinum seed crystal also in this case can be formed. Moreover, it is better to use the seed crystal in the state where it dissociated without forming membranes in the meaning of lessening as the unnecessary component has come out, when not directly related to the function of an element like this platinum crystal.

[0046] Furthermore, the PZT thin film 15 is grown up into the PZT thin film 13 upper surface by the magnetron sputtering method (610 degrees C of temperature conditions), and the PZT thin film 17 of 200nm of thickness is formed.

[0047] As mentioned above, in this example, the PZT thin film 17 is divided into the process of two times, and is formed (with option). After forming the PZT thin film excellent in the stacking tendency which inherited the stacking tendency of a platinum thin film with the first sol-gel method as the first film, the sputtering method is used, a PZT crystal is grown up as the second film, and thickness of the PZT thin film 17 is set to 200nm.

[0048] In addition, next, after making the platinum thin film 19 deposit on the PZT thin film 17 upper surface by the sputtering method, the crystalline titanium thin film 8, the platinum thin film 11, the PZT thin film 17, and the platinum thin film 19 are fabricated by using a resist as a mask and *****ing. next, the platinum thin film 19 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type drain layer 21 and n+ type source layer 23 are formed A memory cell is formed as mentioned above.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a manufacturing process view for the manufacture method of the crystalline thin film by one example of this invention being shown.

[Drawing 2] It is a manufacturing process view for the manufacture method of the crystalline thin film by one example of this invention being shown.

[Drawing 3] It is a manufacturing process view for the crystalline thin film by one example of this invention being shown.

[Drawing 4] It is a manufacturing process view for the conventional crystalline thin film being shown.

[Drawing 5] It is a manufacturing process view for the conventional crystalline thin film being shown.

[Drawing 6] It is a manufacturing process view for the conventional crystalline thin film being shown.

[Description of Notations]

7 ... Titanium crystalline

9 ... Titanium crystallinity thin film

3 ... Titanium crystallinity thin film

11 ... Platinum thin film

13 ... PZT thin film

15 ... PZT thin film

17 ... PZT thin film

[Translation done.]